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ABSTRACT

Twenty-four activities suitable for outdoor use by elementary school children are outlined. Activities designed to make children aware of their environment include soil painting, burr collecting, insect and pond water collecting, studies of insect galls and field mice, succession studies, and a model of natural selection using dyed toothpicks. A group called "investigations" are simple experimental studies of soil inhabitants, succession of burned areas, railway right-of-way ecology, the effects of modifying plant and animal habitats, and fish behavior. The last group of activities introduces quantitive measurements of soil, and air temperature, soil composition, fish population dynamics, and mapping. Teaching hints are included for each activity. This work was prepared under an ESEA Title III contract. (AL)

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OUTDOOR ACTIVITIES

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BECOMING AWARE

SOIL PAINTING

Learn About Soil While You Paint

Soil comes in a great variety of fascinating colors and textures.

Learn about these while you create an exciting design to decorate your room at home, club house or class room.

How to Get Different Kinds of Soil

Bring soil samples from home. Bring enough--about a cupful or two should do.

Plan to take two or three weeks to collect soil, so you and the others in the group will have several weekends to gather soil from places you visit--across town or on trips farther away.

When you bring samples together, you will find that the color-tone variations are subtle--ranging from gold, terra cotta gray and beige to dark browns and black.

Textures may vary from very fine sand and soil particles to pebbles.

You'll Need These Materials to Make a Soil Painting:

Soils and sands of as many colors and textures as possible.

Plastic bags to hold soil.

Water soluble white glue.

Small brushes in two sizes--one inch and one-half inch.

Wood or cardboard. Consider the weight of the piece of wood, since you may wish to frame and hang your final results. If you use a piece of wood with an interesting grain, you can incorporate the grain into the scene.

Here's Where to Gather Soil:

Look for soil wherever you go. Carry a few plastic bags and twistums in your pocket all the time.

Look first in your yard; then the yards of friends and relatives across town.

Keep a sharp lookout when you're at the beach, when you pass a road cut or when you walk along a river or creek bank.

Check every place you can think of. Label bags of soil with location. You may need more later.

General Soil Types to Look For:

These general soil types come in a variety of shades and textures: sand, garden soil, peat, clay, crumbled rock.

Try for variety.

What Sort of Picture?

Spread out your collection of soil samples to see what you've got.

Decide on a scene, design or picture. You can draw an original, or copy something. Good places to look for ideas are greeting cards, crewel embroidery patterns and mod-type magazine ads.

Take picture ideas from nature. Leaves, insects, mammals, birds, flowers, sunsets, under water scenes make good subjects to paint.

When you've decided what you want to paint, sketch the plan. Use cardboard or wood for backing.

Decide which soils you will use in your design and where they'll be used.

Mix the Glue Next:

Fill a jar or glass half full of white glue. Add enough water to fill the container. Keep some glue in the original container, at full strength.

Start Painting

Use a paint brush to stroke glue solution on areas of the picture you want to cover with one type of soil.

Sprinkle soil onto the glue. Leave the soil in contact with the glue until it is dry.

Brush glue on another area of your picture. Choose spots not adjacent to the area which is drying. Sprinkle on soil.

Continue gluing soil in place until picture is complete.

For an Art-ier Picture:

Colors will blend if you work in side-by-side areas when the glue is still wet.

You'll get sharp color distinctions when you wait for glue to dry.

When you want sharp, narrow lines, apply glue in full strength (directly from bottle). Sprinkle soil and shake off excess immediately.

You'll get a raised line by applying glue full strength, then adding soil.

When making a heavy, raised area, mix soil with plaster of Paris and apply immediately. Mix a small amount of plaster with a large amount of soil because plaster causes material to dry a lighter color.

You'll Want to Keep Your Picture

It's not difficult to preserve your soil painting.

When soil is completely dry, stand the picture on a side so loose particles will fall off. Repair any areas that need it.

Spray finished and completely dry painting with plastic or lacquer.

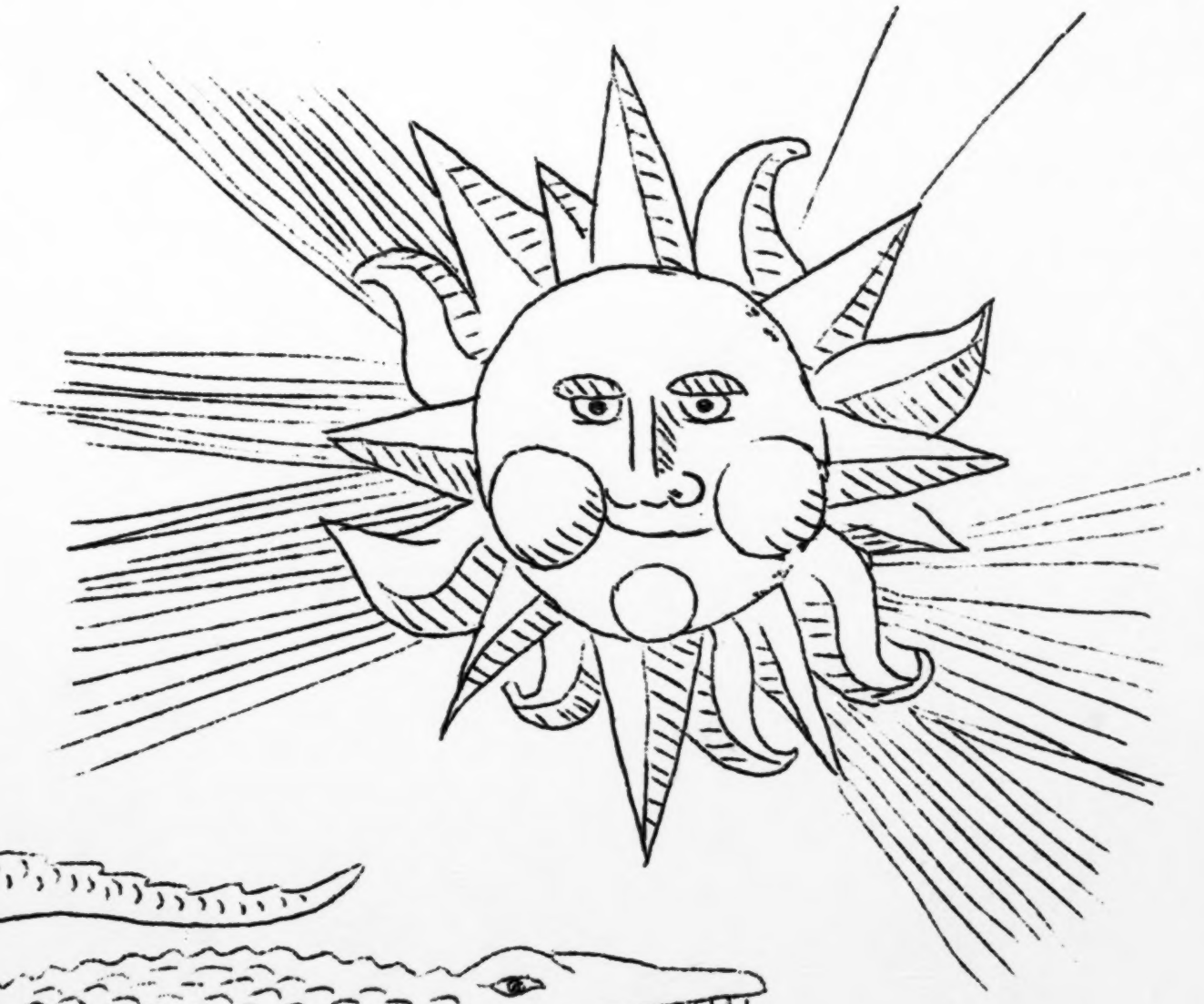
Frame picture if you like.

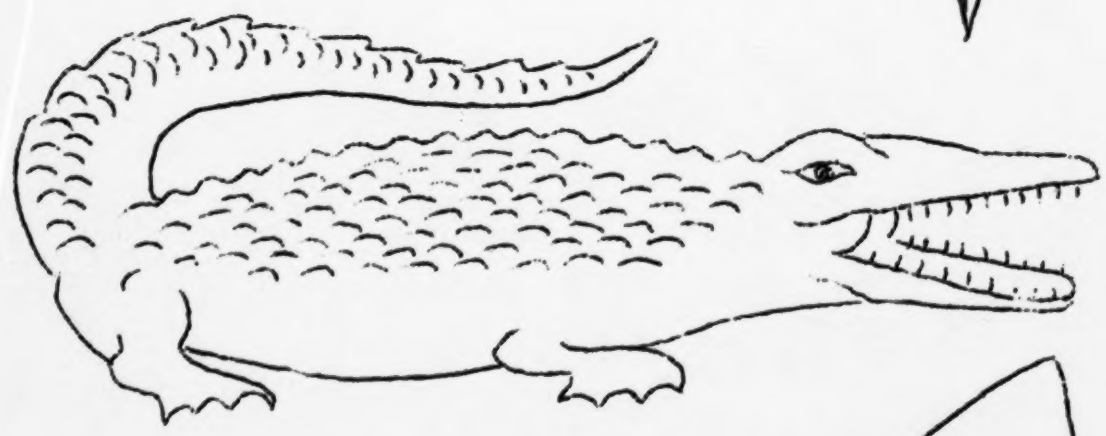
PATTERNS

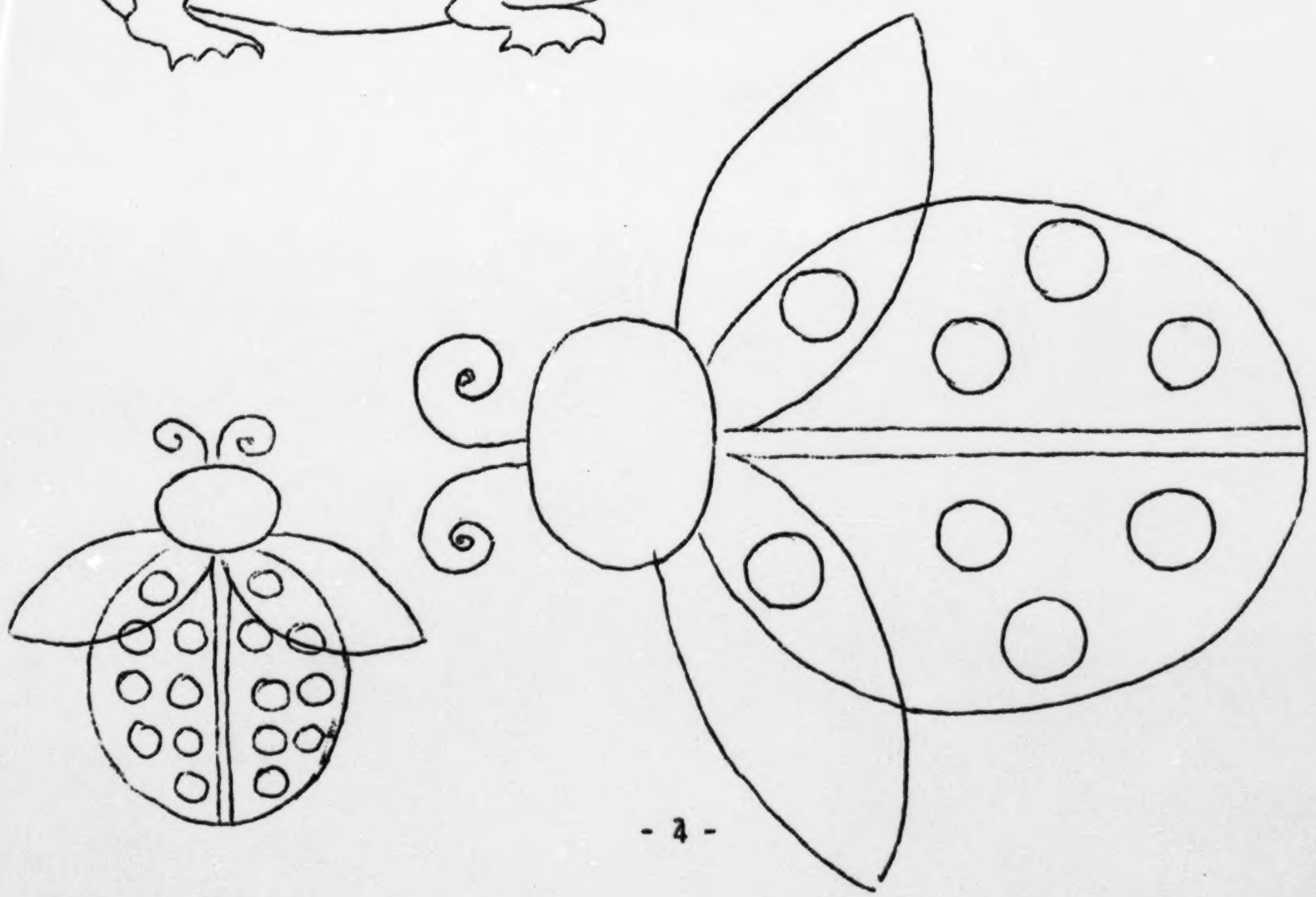
FOR

SOIL

PAINTING







AUTUMN SEED AND BUR ACTIVITY

Pre-Activity

Objective: To find out the best clothes to wear on a Bur-In.

Materials: 1. Some burs, stick-tights, etc.

2. Assorted children

Procedure:

Pass the burs around and see which kinds of clothes they will stick to. Resolve to wear those kinds of clothes on the field trip. Or, make leggings of appropriate material (wooly, although old sheets will work) by wrapping a piece of fabric around children's legs and pinning with safety pins.

Field Trip

Needed: 1. assorted, enthusiastic, adventurous children in old bur-attracting clothes

2. crisp fall day

3. large sheets of white paper (one per person -- leave in classroom)

4. plastic bags

Procedure:

1. Pick out a nice, weedy, brushy area in which to have the Bur-In -- a vacant lot or an old field that has grown up to weeds. The teacher may want to ask the class for suggestions on good places for a Bur-In, then check out the area before the field trip. If there is poison ivy in the area, you will have to take some precautions such as warning the kids not to pick the white berries.

Poison ivy leaves are often bright red or mottled red and yellow in autumn.

However, making a big deal out of it will tend to inhibit the kids and make them reluctant to go through the area.

2. Go to the site of the Bur-In.

3. Walk, run, skip, roll in the grass, play hide-and-seek, pick up litter, look for interesting discoveries, walk through tall weeds, form a

long line and walk side by side, arms distance apart across the area (this may even scare up some mice, rabbits, or birds), etc.

4. Collect samples of as many kinds of plants which produce burs or sticky seeds as children can find. Put them in plastic bag to take back to classroom.

Follow-Up

1. Return to the classroom and have each child remove the burs from his clothing and put them on his sheet of white paper.

2. Glue examples of each type of sticky seed to a large poster board or a long sheet of white shelf paper or butcher paper. If anyone has a sample of the plant that a particular bur came from, glue it up beside the bur.

3. Determine who has the most different kinds of burs and reward them appropriately. There might also be a reward for the person who has the largest number of individual burs (on his sheet of paper!).

4. Discuss everybody's burs. Some points for discussion might be:

   a. Why do burs stick to people?

   b. Do burs stick only to people?

   c. What's inside a bur?

   d. Which burs are the most effective?

   e. What might happen to a bur that got caught on a fox's tail?

   f. What kind of bur is most common?

   g. Did different kinds of burs come from different locations?

   Look at some burs under magnifying glasses.

5. Planting Burs:

   Materials: tongue depressors

   assorted burs

   gravel

   soil from an area where burs grow

   trowels

   access to a refrigerator

Procedure for Planting Burs

a. Put some of the burs in the refrigerator for about a week. If you have a cold winter in your area, the seeds may need to be cold and dormant before they can germinate. You may even want to plant some seeds in the refrigerator and see which ones grow best.

b. Put a little gravel in the bottom of each box, then add the soil.

c. Also plant unrefrigerated seeds in the soil, marking each kind of seed with a marker. The marker could be a tongue depressor with a dried seed (of the type planted there) glued to it.

d. Water the seeds occasionally -- very lightly, just to keep the soil from drying out.

e. Once they start to grow, the plants will probably need a lot of sunshine. But, it is not necessary to grow them for a long time.

f. Sketch the plants at different stages of their development. Do the plants look like any you have seen before?

WHAT'S IN A GOLDEN ROD GALL

It's the Stalk with the Swelling

The tall, common golden rod plant remains standing through the winter, though it is dead and dry.

You find it in, or at the edge of, open meadows and fields.

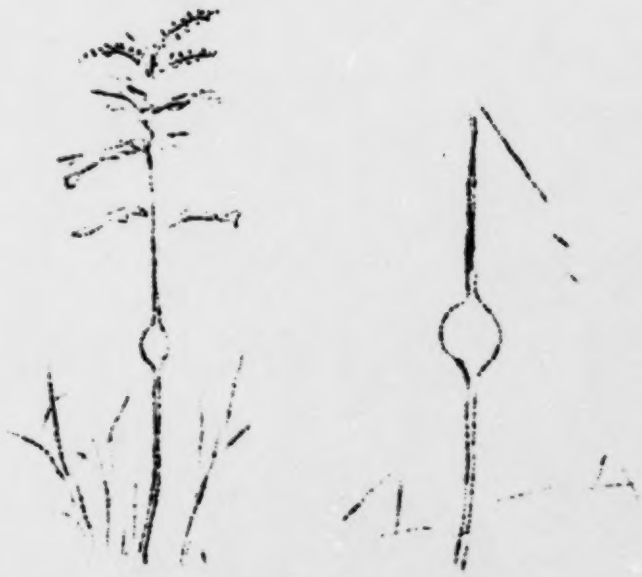
Often the dry plants have an egg-shaped swelling on the stem. This is the golden rod gall.

A Wasp Starts the Gall

The gall swelling is caused by the golden rod wasp which lays its eggs in the stem during summer, when the plant is green and growing.

The egg, and larva that hatches, irritates plant tissues which swell, forming the gall.

The inner lining of the gall serves as food for developing wasp larva after it hatches from the egg.



Check These Spots for Galls:

Hunt for golden rod galls during February or March.

Look in almost any vacant lot, field, weedy ditch or border area.

Have a number of glass jars available to hold the galls.

What to Do with a Gall Collection

A collection of galls can be experimented within a number of different ways. Here are some. You may think of others. Here are three preparations to make for experimenting with gall-wasps.

Preparation I: Carefully cut some galls open with a razor blade or sharp knife. Make the cut parallel to the stem, but off-center.

The larva should not be disturbed, as it lies in the center of the cavity.

Trim the cut so the larva is clearly visible. Place glue around the cuts and fasten edges to the inside face of a glass jar. This forms a window through which the larva can be viewed.

Cover the jar with a piece of nylon stocking. This allows air to enter. Label jars.

Preparation II: Cut the galls, as described in the first preparation.

Remove the larva from the opened galls and place larva in a glass jar covered with a nylon stocking. Label jars.

Preparation III: Leave some of the galls unopened. Put them in a glass jar with a nylon stocking cover. Label jars.

When Environment Changes--What Then?

Light, moisture, temperature, air movement--these are some of the things that make up environment. What happens to living things when these change?

Will the larva in the golden rod galls be affected?

Depending on the number of galls you've collected, make some or all of the following tests. Maybe you can think up others.

Test I: Does the amount of light affect the development of the larva?

Fasten dark paper around containers of galls from Preparation I, Preparation II and Preparation III.

Leave an equal number of galls in the light.

Test II: Does the amount of moisture affect the development of the larva?

Keep dampened sponges in one set of containers. Moisten the sponge every day.

Run this test on containers of galls from Preparation I, Preparation II and Preparation III.

Test III: Does temperature affect development of the larva?

Take several thermometers and find spots in the room which stay at different temperatures (like a window or air vent).

Check these temperatures each day, for several days, to make sure they are nearly the same (a variation of 5 degrees is permissible).

When several spots have been found, place containers of galls from each of the three preparations in these places.

Don't forget to check the containers daily. Keep a daily temperature record. Record what's going on in each container every time you check. Include date and preparation number of the container, too. Use record sheets like this sample.

SAMPLE RECORD SHEET
for
Golden Rod Gall Experiments

PREPARATION I

Date Temp	Observations Test I	Date Temp	Observations Test II	Date Temp	Observations Test III
----- -----		----- -----		----- -----	
----- -----		----- -----		----- -----	
----- -----		----- -----		----- -----	
----- -----		----- -----		----- -----	

Notes to the Leader:

Try to maintain as much suspense as possible during this investigation.

It is not necessary to tell the children what they will find when they cut their galls open.

The fact that this little worm-like creature is called a "larva" is not even too important.

And, it certainly is not necessary for them to memorize that the larva becomes a pupa, which becomes an adult wasp. They will see this happen.

About two to three weeks after bringing galls in, wasps will begin to emerge. If the children do not know that a wasp will make his appearance, they will be much more excited when he does.

The more galls the better as not every gall successfully produces a wasp.

These wasps do not sting or bite.

Other Surprises:

The children will make other discoveries...usually without urging. For example:

The larva eats out an "escape tunnel" for the wasp before the larva becomes a pupae.

The pupae is hard and oval, and does not move.

The wasp pushes through the skin of the gall by inflating a balloon on his head.

The wasp has folded, crinkled wings immediately after emerging.

After emerging, the wasp sits on the gall until the wings straighten out and the balloon on his head collapses.

FIELD MICE

Field mice might be living in the vacant lots near your school. This is almost certain if the lot is low and moist with dense vegetation. Look carefully for the runways which will honeycomb the ground surface just below the matted vegetation. Look for entrances which are sometimes round holes or separations in the vegetation. Follow the runway by carefully parting the vegetation. Droppings, nests, and entrances to underground tunnels will be found along the runway. If there is snow on the ground it is sometimes easier to locate the runways. The best snow conditions for this are found during spring when the snow has melted to about two inches depth with a crust on top. The raised outline of runways can often be seen on the surface of the snow. The entrances are round holes or cracks in the snow. After a fresh snowfall you might see where the mice have run across the surface of the snow.

A small garden trowel works well for lifting the roofs off the runways but is not necessary. Tack paper to a board to keep it dry and stable for recording. Plastic bags can be used to enclose items found along the runway such as droppings and nests.

Each team measures and marks off an area that they stay within when recording. Warn them not to trample the area, but to sit down and carefully begin to examine the area from the edges.

Grid Mapping can be adapted for use in mapping the field mice runways.

A FIELD OF INSECTS

You are a lucky group if you have open, grassy fields available. During the spring, summer and fall, different plants come into blossom, go to fruit or nut, and then die off. During these stages, insects visit the plants for a variety of reasons. A study of insects that visit the blossoms can be made with an insect net. There are many plans in science books for the construction of insect nets. You can make your own nets using one of these plans. Otherwise, ready made insect nets can be purchased from biological supply houses for as little as $4.00 each.

When the field is in bloom the students may sweep certain flowers (all of one kind) with the nets. Warn them that they may not see the insects until they are in the nets.

Make a simple killing jar by simply pouring about three tablespoons of denatured alcohol into a plastic bag and closing it with a wire twister. (A solvent-cleaner like Synasol works well as a killing solution and is inexpensive. It's available in hardware and paint stores.)

To mount the insect collections, give the students heavy paper or cardboard and white glue. Allow insects to dry before mounting. Mount each insect by placing a drop of glue on the paper, place insect on top of the glue and gently settle it into the drop. Glue dries almost clear. The insect is visible and probably in better shape than if ten awkward fingers had tried to pin-mount it.

A pressed, dried sample of the bloom to accompany the insect collection is valuable. Press the flower in newspaper beneath heavy books for one week (longer for their petals). Place a square of transparent plastic food wrap over the flower and tape to a flat surface.

If there are several flowers (weeds, bushes, grasses, etc.) in bloom at the same time repeat the sweeping procedure on each flower. Be sure to keep collections separate, dated and labeled!

Later in the season still other flowers will appear. As each plant blossoms, it should be studied by the class. A series of collections for each blossoming plant can be made for the field.

Questions which will arise as the class studies the collections include some of the following:

1. Is there one kind of insect which is found in great numbers for each blossom?

2. Are there some blossoms which insects do not seem to visit?

3. Do some insects appear in greater numbers than others for several types of blossoms?

4. Does the type of accompanying insect change more with the type of blossom or the time of season?

5. Are there some insects which are not found at all in collections during certain times of the season?

6. Are insects that visit "good smelling" flowers different than the insects that visit "bad smelling" flowers?

7. Do certain types of insects visit only one color of flower?

SUCCESSION ACTIVITIES

Introduction

People who work with the natural environment speak of the "balance of nature." This "balance" is not a steady, unvarying thing, but it is a condition where each of thousands of factors, including wind, trees, birds, dust, houses, and ants, remains in fairly constant, predictable co-existence. But, obviously, the existence of any one factor is modified by the presence of all the other factors.

All these thousands of factors get into "balance" by existing with each other for a long period of time -- several years or perhaps several thousands of years. Their effect on each other evens out in time.

If one factor in this "balance" is changed or removed, there is generally an unpredictable change among the thousands of other factors which were originally in balance with the one.

The change is unpredictable because it is almost impossible to measure all the thousands of ways that the changed factor affected the others.

Sometimes this "imbalance" will hardly be perceptible. Sometimes the "imbalance" will result in extremely different behavior of the other factors. This new behavior may last only a short time until a new "balance" results or the extremely different new behavior may become the new balance. Always, however, whether one factor or many are changed, or whether the results are hardly perceptible or great, there will be a new "balance" which is different from the original.

This change in "balances" is called succession. Succession is a naturally occurring phenomenon. It is a natural process which usually occurs very slowly. However, because of the many large changes due to the presence of man's technology within the natural setting, succession has been proceeding much more rapidly in the past few years.

Man is now able to decide yes or no about some of the "natural balance" changes which his technology causes. Before succession proceeds so rapidly that he cannot keep pace with it, it would be well for man to be better educated about what succession really is.

The following activities for studying succession will acquaint students with a natural phenomenon that may become man's primary concern within a very short time.

Rotting Fruit

Objective: To observe the change brought about through decomposition of plant material and note the associated occurrence of mold growth.

1. Have each child choose a fruit or a vegetable that they can collect in the local area or bring from home.

2. Obtain pint mason jars and lids, one per child.

3. Have the children seal their chosen fruit or vegetable in a jar with his name and the name of the fruit.

4. Set the jars aside where the children cannot see them. Decide upon a certain time each week when the students will make observations on their fruit and record any changes that have taken place over the week. Continue to make these observations over the entire school year.

5. Keep a chart of information on the bulletin board noting all significant changes. Things to watch for and include on this chart might be:

   a. the first fruit or vegetable to become molded (give name of fruit or vegetable and describe mold)

   b. the first to become discolored (give the name of the fruit or vegetable and describe discoloration)

   c. the first to release a juicy substance in the bottom of the container

   d. the first to become misshapen

   e. the first to collapse

   f. the first to form a second discernible type of mold

6. At the end of the year or when the fruits and vegetables have all become completely decomposed, number the bottles. Do this without the children knowing. Record for your own information which number belongs to which student and what fruit or vegetable was contained in that jar. Remove the name tags. Mix up the jars so the children can't identify their own jar by its position on the shelf.

   a. Have the children see how many of the fruits and vegetables they can identify in this decomposed state. They could write the jar number down and their guess beside the number.

   b. Ask the children to retrieve a jar which contains the type of fruit or vegetable they brought. (They need not retrieve their own jar -- just a jar containing their type of fruit or vegetable.)

   c. How many children were able to retrieve a correct jar? What characteristic did they use to identify the correct jar?

   d. Who identified the most correct fruits or vegetables which were identified more often than others? What were the characteristics the children used when they correctly identified a fruit or vegetable?

A Light in the Night (for warm months of the year)

Objective: Changing the "balance" of the normal environment by placing light and heat where it would not normally be predicted.

Materials: light bulb socket and extension cord
100 watt light bulb
wooden stake, one foot long
string

Procedure:

Pound the stake two or three inches into the ground at the edge of a brushy overgrown area. The edge of a vacant lot will work, or the brushy edge of a lake or pond, or the edge of a woods.

Fasten the light socket to the top of the stake with string. Put in the bulb, then attach the extension cord, being careful not to short or ground the electrical connections. A three wire, grounded cable should be used for greatest safety.

Leave the light on overnight on a calm, warm night. The light will attract insects (mostly moths). This alone is a change in the normal interaction of natural factors. The heat from the light plus injury and exhaustion will kill many insects which will drop to the ground in a pile by the stake. This accumulation of dead organic material will affect other factors and may in turn cause a change in local conditions.

Mice may be attracted to feed on the dead insects, flies may lay eggs on the decaying pile, decay may cause a change in soil and plants around the stake.

A calendar record of observations, mainly any observed change of conditions, should be kept from observations made periodically during both day and night time for one or several nights.

The record of change is a documentation of succession caused by a lightbulb.

Natural Selection Upon Toothpicks

A child most often comes to regard the appearance and behavior of a plant or animal as something of that organism's own choosing. The plant grows a beautiful flower because it wishes to be beautiful. The cat stalks the bird because the cat is naughty. The fish come to the side of the aquarium because they want to be fed. Cattails grow in the pond because they like the water. The trees grow tall because they need the sun.

Our problem is mainly one of language and over-simplification. Our language developed to express ideas and information from a human point of view -- from a point of view that assumes that humans make decisions and choose all their actions. Perhaps it is accurate to say, "John puts on his coat because it is cold outside." This implies that John chose this action and this is probably realistic. However, we run into some trouble of confusing a child's understanding of reality when we use the same language to refer to the behavior of something other than human. To say,"The horse puts on his winter coat because it is cold outside" is not wrong, but it is not realistic either. It states a situation about a horse in the same language we used for John, and to the child, this implies that the horse also chose its action.

We may never get away from our language problem. But why not use some other means to communicate the reality of an organism's situation. Activities allow children the potential for a greater latitude of insight than verbalized instruction. The following is an activity which deals with a concept that is often misrepresented by verbalized instruction.

Background

Most insects that live on plants are green or grayish in color. Ask children to recall insects they have seen and what color they were. The children will not remember the color well, but rarely will the insect be a species which is green. The children may assume that most plant insects are not green. However, they are probably just not seeing the green ones.

Insects that live on the ground are usually brown or black. The children may agree here. But most insects that live on the ground are very tiny (pinhead size). The ground insects that children know are large. To resolve all this we can state verbally, if we must, "The insects are green or small so that we won't see them", and we will be linguistically logical, but realistically quite wrong. We imply again that the insects choose to be green. The more realistic statement is, "The insects are green because we haven't seen them (or because they haven't been seen)", but this doesn't make sense to us, let alone to the children. That is, it doesn't make much sense spoken, but it does make sense in practice. Therefore, let's not try to explain it in words, but have children learn it by experience. The following is an activity which will demonstrate what we haven't been able to explain above.

Natural Selection Upon Toothpicks

(Adapted from Grade Teacher, January, 1969, p. 105 and David J. Kuhn, The Science Teacher, January, 1969, p. 68)

Materials: food color or tempera paint (green, yellow, red, brown, black)
box of toothpicks
plastic bags

Color equal proportions of the toothpicks each of the colors plus no color or the natural white color of the toothpick. Dip the toothpicks in the color, then let dry. Mix the toothpicks together. Then, before class, scatter them widely over some one selected outdoor area, such as a lawn, open dirt, playground, leaf litter, under trees, sidewalk, etc. Work the toothpicks into the grass or litter.

Present the activity as a game to the children. They will play the part of birds who are hunting insects for food. They can't use their hands to feel for food (birds don't have hands), only to pick up what they see.

Show the children what the insects will look like. Show them a sample of each color of toothpicks. Give each child a bag.

Take the children outdoors to the "insect" hunting site and let them go to work. Call time after five or ten minutes. The children should carry the collected toothpicks in the bags. The children can record the respective number of toothpicks on a chart of their own.

In class, or outdoors if it's nice, tally up the number of each color toothpicks collected by the whole class. Record this on a large chart.

Generally, if you scattered the toothpicks widely enough and called time soon enough, and if one or more of the colors matched the collecting site, there should be a difference in the numbers of toothpicks in different color groups. In green grass there will be obviously fewer green toothpicks recovered, etc. because they will be more difficult to see and find.

If the toothpicks are insects and the children are birds and the birds keep hunting for insects all season, the children should be able to offer their own hypotheses (based on the toothpick collecting only) about which color insects will most likely still be left at the end of the season.

If you started with the lawn, do the children's hypotheses hold for other areas such as those listed above? Test it out. Use the same proportions of toothpicks on dirt or the sidewalk, etc.

Can the children predict what color insects can most easily hide in the other areas? How do most insects living on plants come to have a green color?

A Fishless Aquarium

Hours of intriguing investigation result from a simple pond water aquarium. Children are fascinated by the creatures found in pond water and can easily become familiar with them. As children compare jars of pond water and, later, the water from different ponds, they begin to understand that living things are different in different environments.

Material for a fishless aquarium can be collected on a class outing.

In preparation for the outing, ask each child to bring a one-quart milk carton and a one-quart clear glass or plastic container. Take the milk cartons on the outing. Each child will collect a sample from the pond, ditch or lake visited.

Collect material this way:

1. Carefully unfold the top of the milk carton so you have a square opening. Rinse out all traces of milk.

2. Take the milk carton to the pond, lake or ditch. Scrape a little mud off the bottom and into the milk carton. You can use the milk carton to scrape with. If you scoop the mud up with some other container, be careful not to wash away creatures contained in it.

3. Measure the depth of the mud you have scraped into the carton. Poke your finger into the mud and make the level of the mud the same as the height of the first joint on your index finger.

4. Fill the rest of the carton with clear water.

5. Add a small handful of any dense water plant that is available. Many animals live in the plants and will be transferred to the carton with the plants.

6. Refold the top of the carton. You may tape or staple the top together before carrying it away.

7. Dump the sample from the carton into the quart jar. Rinse the carton by pouring some water from the jar back into the carton. Shake the carton with the water. Then pour the rinse water into the jar. Don't worry about how cloudy the water is. It will settle and clear if left undisturbed for several days. If jars are set in windows, plants will stay healthy.

8. Shake the plants free of mud.

After the mud has settled, children can study the jars' contents closely...now the fun begins:

1. Are there creatures swimming in the water of the jars?

2. Are there creatures on the sides of the jars?

3. Are there creatures on the surface of the mud?

Microscopes or magnifiers can be brought out when the children have exhausted the observations they can make with their eyes. If you only have a few microscopes these might be placed in a quiet corner of the room where the children can go after finishing other work. Encourage them to record their observations with pictures and words. These might be put on a bulletin board.

The class may observe the creatures in their jar for quite some time before they will raise such questions as the following. Be patient! These questions will be raised by the children as a natural follow-up to their observations.

1. Does my jar have the same creatures as everyone else?

2. Does my jar have as many creatures as someone else?

3. Is the population changing in my jar? Is the number of one creature increasing or another decreasing?

4. Is the color of my water the same as everyone else's?

5. Is my mud the same as everyone else's?

These aquariums will last for several weeks. To assure this, some precautions should be taken. (1) Don't add food to the water! (2) Keep some distilled water on hand to add as the pond water evaporates. (3) Keep the jars in the coolest part of the room. (4) If there are some green plants, keep the jars in the light.

INVESTIGATIONS

SOIL IS ALIVE--AND HUNGRY

Dig Down to Where the Action Is!

Do you ever wonder what happens to the leaves, bugs, berries and small animals that die and fall on the ground?

Does something eat them? Do they simply rot away?

Actually, there's a whole, very-much-alive world of life in soil. Plant and animal remains that lie on, or in, the dirt are chewed up and decomposed by various organisms.

Some organisms prefer certain types of materials over others.

Take leaves, for example. It's fun and easy to dig down and find out Which hungry soil organisms prefer leaves...and what leaves they like best.

To Find Out What Diet's Preferred You'll Need (For a Group Project)

1. Several large plastic or glass containers with covers. These should be about 9x12x4 inches. Plastic shoe boxes work well.

2. Magnifying glasses or hand lenses.

3. Trowels or digging tools.

4. Dissecting microscope, if possible.

5. Tree identification book.

6. Pencils and paper.

7. One large piece of paper for a map.

8. Six or eight individuals or teams of students.

Where to Collect Soil:

Each individual or team needs a large plastic box with cover, digging tool, paper and pencil.

Take this equipment to the chosen spot...a woods, meadow or some other relatively undisturbed place.

Carefully dig up some of the top layer of soil. Put enough in the plastic box to cover the bottom with one inch of soil.

Remove all growing plants and dead leaves from the soil in your box.

All teams should get soil from the same general area.

The most "alive" soil is found where man has disturbed it least. There are many more soil organisms in a meadow, for example, than in a field that is plowed each year. Sandy soil has fewer organisms if there is no ground cover.

Next, Draw a Map.

Draw a large group map of the area where samples were collected. Mark the location of each sample.

It is important to know if the soil is from a forest or field; from under a tree or out in the open; from a low marsh or a high hill. Location will make a difference in the kinds of soil organisms and what they eat.

Describe the Spot.

On a sheet of paper, describe the plants or trees growing in each soil sample location.

Is it an open field with mostly grass growing in it? Or, is it a brush area with bushes and small trees? Are there tall trees, or is it a marsh? Is the ground covered with vegetation or dead leaves?

Describe the Soil.

Pick up some soil and work it with your fingers. Describe the moisture content of your soil sample.

Dry soil is crumbly, feels dry, falls apart easily when you handle it.

Moist soil feels damp to the touch, or maybe spongy.

Wet soil drips water when you pick it up or squeeze it.

Describe the texture of your soil sample.

Sandy soil is made up of grains of sand.

Clay-ey soil sticks together in clumps; has lots of clay in it.

Loamy soil is made up mostly of dead leaves and other organic matter.

The Data Sheet for team work may be copied and used as a handout to help teams describe their soil.

To Start Action in a Soil Box:

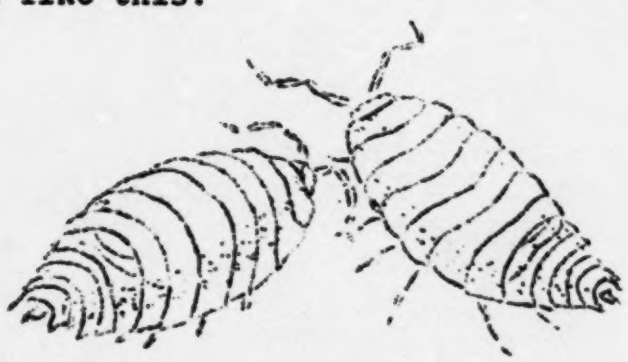
Look for sowbugs and leaves. This activity may be included in the soil collecting field trip, or it may be done at a later time.

If it is done later, soil boxes may be left on the shelf, and materials collected in large plastic bags.

Each student or team should collect materials for his or their own box.

Where Do Sowbugs Live?

Look in cool, dark, moist places for sowbugs or pillbugs. Check under logs, stones, boards, leaves and other like places to find these little isopods. They look like this:



Capture about 10 of these bugs with your hand. They don't bite. Put them in the soil box or a plastic bag.

You'll Need Leaves, Too.

Find three or four dead leaves from different kinds of trees. Try to find leaves that haven't been chewed or broken.

Dead leaves may be picked up under the tree.

Live leaves, picked off a branch, may be killed by submerging them in boiling water for a minute or two.

What Kinds of Leaves?

Leaves should be chosen from the following table, if possible. You may need a tree identification book to find the various types. Choose only one leaf from any group.

Group I	Group II	Group III	Group IV	Group V
1. black elder	1. alder	1. spruce	1. basswood	1. oak
2. hornbeam	2. ash	2. beech	2. maple	2. birch
	3. elm	3. red oak		3. aspen
		4. pine		
		5. Douglas fir		
		6. larch		

Put the three leaves in your soil box, lying flat on top of the soil. Put in the sowbugs, too, if you haven't already done so.

When everything is inside, put the cover on and place the box in an easily accessible place--away from heat and sunlight. If the top is kept on, the box should stay moist enough for the soil organisms. If the soil starts to dry out, sprinkle it very lightly with water. Check the box every day.

Watch the Box and Record Activity

Watch your team's box carefully. Do you see any signs of life besides the sowbugs? There may be some worms, insects or spiders. Look at them with magnifying glasses or the microscope.

Inspect the dead leaves in your box very carefully each day. Have any of them been chewed on? Which of the three or four types of leaves appear to be the most attractive to the soil organisms? Record your findings on a team data sheet.

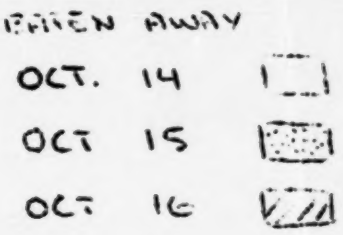
After several days, compare your observations with those of other teams to see if you can work out a list of which leaves get chewed up and decomposed first. Use a group data sheet.

For example, if every team which had a maple leaf or a linden leaf in its box found that this leaf was chewed on the first day, before any other kind of leaf was touched, these leaves would be the most attractive to the soil organisms. If elm leaves are chewed next, these would be second in order of preference.

You may be able to tell which organisms are eating the leaves by actually catching them in the act, or by finding their droppings. Sowbug droppings are small, brown and sort of rectangular.

The leaves that are being decomposed in the soil box may be chewed in different patterns. Some leaves may be eaten out between the veins, some may be chewed full of holes, and some may be simply devoured from one edge to another. Are the eating patterns different on your three leaves?

Draw a picture or "map" of each of your leaves. Indicate in different colored crayon or chalk how much is eaten each day. You may also want to take pictures of your leaves each day.



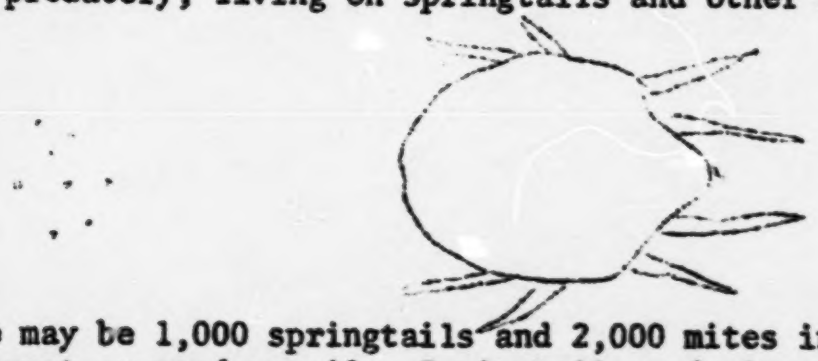
Other Creatures Decompose Leaves, Too.

Several other creatures, besides the sowbug, help decompose leaves.

Earthworms ingest (eat) particles of leaf and mix them with soil in their bodies. Their droppings, called earthworm "castings," help to enrich the soil, and their burrowing helps to aerate (let air into) it.

Springtails are small insects which occur in large numbers in soil. Most of them eat decaying vegetation. Most springtails have spring-like contraptions on their abdomens that enable them to catapult several inches into the air when disturbed.

Small mites, relatives of spiders, are about the size of a pin prick and usually occur in even larger numbers in soil than springtails. Most of these are predatory, living on springtails and other small soil animals.



There may be 1,000 springtails and 2,000 mites in 3 cubic inches of natural forest or meadow soil. Springtails and mites will probably be the animals you will most often notice on the leaves in your soil box.

If the soil is moist or wet, there may also be some slugs and snails.

If it is too moist, mold will grow.

DATA SHEET FOR SOIL IS ALIVE

NAME _____

Describe location where soil was collected:

Describe Soil:

Moisture Content -- choose one

1. DRY - crumbly, feels dry, falls apart easily when handled
2. MOIST - feels damp to the touch, or maybe spongy
3. WET - drips water when picked up or squeezed

Soil Texture -- choose one

1. SANDY - made up of grains of sand
2. CLAYEY - sticks together in clumps, has lots of clay in it
3. LOAMY - made up mostly of dead leaves and other organic matter

	Type of Leaf	Date First Chewed Upon	Date Finished
1.			
2.			
3.			
4.			

GROUP DATA SHEET FOR SOIL IS ALIVE

Group	Type of Leaf	Date First Chewed Upon	Date Finished	Comments

EFFECT OF SOIL MOISTURE ON GARDEN SLUGS*

Slugs react to the amount of moisture in the soil by laying a different number of eggs. Soil moisture is an important factor in the lives of all soil organisms (see ESC Sowbug Behavior). By conducting this simple slug experiment, students can begin to understand effects of soil. Students prepare soilscontaining different amounts of moisture and count the number of eggs laid by the slugs in each soil.

Slugs can be found quite easily in damp places where there is an abundance of rotting vegetation. Students should look closely in gardens, fields, and around the edges of ponds. Close to the soil and beneath matted vegetation is their most likely hiding place.

Materials:

wide mouth jars
dried soil (place in an oven at 200° for four hours)
peat or other moisture holding material (sold for potted plants in variety stores)
small squares of cloth to cover mouth of jar
rubber bands to hold cloth down
measuring cups
20 slugs per team of students

Procedure:

Add 1/8 cup peat or other moisture-holding material to one cup dried soil, mix, and place in wide mouth jar. Each team prepares four of these jars. To one of the four jars add 1/16 cup water, to a second jar 1/8 cup water, a third receives 1/4 cup water, and a fourth 1/2 cup water. Label each jar with the amount of added water.

Lay a flat piece of wood, tar paper, or cardboard on the surface of the soil. Add 6 slugs to each jar. Cloth fastened down with the rubber band forms the cover.

Check the jars each day for five days. Count and record and remove the eggs layed by the slugs each day. The eggs appear as groups of round shiny white spheres about the size of a pin head. Most eggs will be found on the bottom surface of the flat material. However, check the entire surface of the soil. What is the total egg production for each jar? Compare the data taken for the different jars. What conclusions does the class come to?

Moist cotton is a good incubating material for the eggs removed from the jars each day. Keep this in another jar for about three weeks. After ten days, examine daily and count the number of eggs hatched. What is the average length of incubation for slug eggs?

Young slugs can be fed lettuce.

*Introduction to Experimental Ecology, Lewis, Taylor; Academic Press, London - New York; p. 137.

RAILROAD ECOLOGY

It is interesting to note that the railroads which once pushed back frontiers to make way for civilization have become one of the last bastions of natural systems within metropolitan areas. Prairie successional types found on the city right-of-ways are essentially the same as those once found in the countryside. The easy accessibility of these areas to schools provides a quick and efficient means of involving children in meaningful studies of the environment. A little respect for the trains will remove the only serious objection to using right-of-ways as classroom adjuncts in your outdoor education programs.

Taking Samples from a Plot

Each child or team should find two plots along the track to investigate. The second plot should be located exactly opposite the first, on the other side of the tracks. By sighting through a rounded coat hanger held at arms length they can stake out the boundaries of their plot.

Each child should stand the same distance from the embankment when sighting. Each child should have a large plastic bag for the first investigation. This investigation can be conducted as a scavenger hunt.

1. Children collect one individual of each type of plant found. This is done separately for both sides of the railroad track embankment.

2. Mount these plants on white paper with tape.

3. Label each paper with location and student's name.

4. Compare collections for likenesses and differences.

5. Whose plots had the greatest variety of plant life?

6. Was there any difference in the types of plants growing on one side as opposed to types on the other side of the embankment?

Measuring Differences

Give the children thermometers, small plastic bags for soil and two large plastic bags (one labeled "Side 1" and one labeled "Side 2").

1. Have them again select and sample one of each type of plant. They must keep the plants from one side of the railway separate from plants on the other side of the railway (Side 1 and Side 2).

2. Using their thermometers, they can look for differences in temperatures in many different spots on both sides of the railroad track. They should record all their temperatures along with a description of where they took the reading (top of plot, under railway tie, etc.).

3. In the small plastic bags they should place small soil samples, scraped up with a stick. Several samples from different spots in each plot should be adequate. On a slip of paper in the bag they should note moisture as (1) wet; (2) moist; or, (3) dry.

4. Each student can display his collection and data so everyone can see what he has. Stiff cardboard works well. Discuss, compare and contrast the collections and data. Questions which might be asked include the following:

a. Did everyone find that there were different types of plants found on one side and not on the other?

b. Was the same difference in plant life found for the plots of all the children?

c. Were all the plots along one side similar in plant types?

d. Were the differences in the plant types between the top and bottom of the embankments? Can conclusions be checked out?

e. If there were plots that had plant types different from the average collections, can they find some possible reasons why? Refer to temperatures, moisture, soils, and remember how that part of the tracks compared to the rest (high, low, turned a corner, shaded).

f. If you have students coming from farms, do they recognize any crop plants growing in the plots? Are there grains laying beside the tracks? Why?

g. Is the soil type very different within or between plots? If so, why might this happen in this small area? (Fill-dirt might vary in type within a small area.)

h. Can they find any possible connections between temperature and a type of plant? ... between soil and a type of plant? ... between moisture and a type of plant?

In some areas, the land beside railroad tracks is the only natural land left. It may contain remnants of the original prairie land, the original forest types.

SUCCESSION STUDY ON A BURNED AREA

Materials:

Tempilaq - Tempil Corporation
132 W. 22nd Street
N. Y., N. Y. 10011
Approx. $2.00

Asbestos squares - Hardware Store

Procedure:

Tempilaq is a heat recording material. Tempilaq is available in a temperature recording range from 113° F. to 1500° F. in liquid or pellet form. The Tempilaq comes in different colors and each color melts at a different temperature.

1. Place the Tempilaq colors on asbestos squares. Lay these squares on the ground in several spots around the plot that is to be burned. At these same locations, bury squares at different depths in the soil. Obtain some metal poles or heavy wire that will support the Tempilaq and asbestos square. Place these at different heights and locations around the plot.

2. Record and map the vegetation in the plot before burning.

3. Photograph the area before burning.

4. Have the class devise other projects to perform before the burn. For example, they might collect soil for seed germination tests before and after the fire. They might check the moisture content of the soil at various levels before and after the burn.

5. Burn the plot. Contact your local fire department for advice and assistance.

6. Photograph the plot during the fire.

After the plot has burned and cooled:

1. Check the Tempilaq to find the temperatures reached during the fire. Generalize for temperatures reached over the entire plot from this data. Prepare temperature maps for horizontal temperatures and for vertical temperatures.

2. Re-map and record for surviving vegetation.

3. Dig out the roots of various plants and note their condition. Compare these with a root of the same plant taken before the fire or from another area.

4. Continue other projects (seed germination of the soil, soil moisture, etc.).

Annually or at other time intervals, check the vegetation by the same method. If possible, over a long period of time, adjacent plots may be burned at intervals of one, five, or ten years to provide a series of artificial succession stages from which future classes might benefit.

MODIFYING HABITATS FOR PLANTS

Preparing study plots permits an investigator to: (1) control conditions; (2) make side by side comparisons; and, (3) develop much data from relatively small areas. Camp sites and school grounds are excellent for establishing a number of different plots since: (1) space usually permits their development; (2) controlled traffic ensures they will be relatively free of disturbance; and, (3) the study of such plots would be consistent with a conservation or science study program.

A plot could be one yard square or one acre square. Its size would depend upon the modification intended and, of course, the availability of land. The modification or alteration of the land could be anything from simple plowing, to the deliberate planting of, for example, prairie flowers. The following suggestions will work well for modifying and observing adjacent plots of ground of a 10 x 20 foot size.

1. Plowed - the strip is plowed every year and left. Counts of the kinds and numbers of plants which seed in "naturally" and grow over the summer should be made.

2. Burned over - carefully burn in the late fall or early spring to simulate one of the natural means of "management." This plot is then left as it is. Again, records of what plant types seed in, how many of each, when they appear, etc. should be kept so that comparisons can be made. Several plots which are burned at different times of the year can be compared.

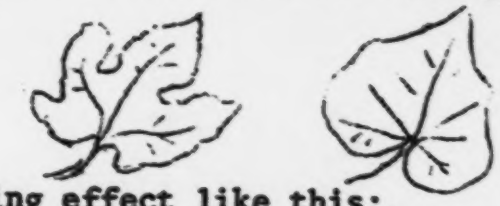
3. Untouched - this plot is left as is and serves as a "control" or standard for comparison. Careful records should be kept of what grows there. Specimens obtained from this plot can be pressed, dried, and preserved in a standard collection and retained for purposes of establishing an herbarium. These specimens could be examined and discussed for a rainy day activity some time in the future.

4. Fertilizing either the plowed strip or adding a fourth plot to which fertilizer is added.

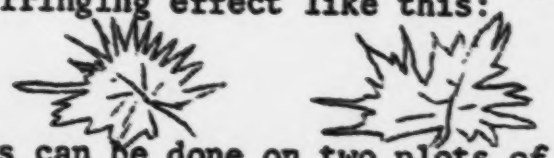
5. Introducing or transplanting "foreign" species of plants to test their ability to grow in such soil. Examples might be the types of plants normally found in swamp or bog areas.

6. Controlled destruction of soil micro-organisms followed by the introduction of plants. The growth of these plants would be compared with those planted on another untreated plot. Arsinate of lime worked into the soil could be used as the killing agent (adults only handle this compound!). Or, a safer substitute would be an agricultural pesticide. (Use only according to specifications on label.)

7. The effect of insect pesticides or herbicides on plants could be studied by applying one chemical agent on each of several plots. Compare plant growth between the two plots. 24D does "strange" things to grape leaves. Recall that the wild grape leaf is shaped something like this:



24D produces a fringing effect like this:



8. Crowding studies can be done on two plots of exactly the same size. In one plot plants of a selected species are planted close to one another. In the second plot plants of the same species are planted at a greater distance from each other.

   This study can be conducted with any species of plant although it is often done using pine trees in a reforestation project.

Other plot studies can be suggested by the students. Much ecology can be learned by carrying out relatively simple study plot experiments. Students come to realize something of the interdependence of biological and physical factors operating to influence growth and reproduction of plants. The alteration of any <u>one</u> factor could ultimately affect <u>all</u> factors.

Studies on plots are most motivating to students when they compare conditions in an attempt to solve a predetermined problem, such as what is the best time to burn a plot to promote growth of grass in preference to woody plants or vice-versa, or do universal insecticides work better or worse than a specific agent in protecting a given plant or a community of plants.

MODIFYING HABITATS FOR ANIMALS

The study plot method of investigation is a valuable way for youngsters to learn something about major ecological processes since they are actively involved in the planning, construction, maintenance, and observation of their own study areas. Active involvement in an investigation of ecology and conservation is a personal and intensive experience for youngsters. There are many interpretive kinds of programs in which youngsters are passive observers, but since the ultimate goals of all conservation programs have to do with the establishment of positive attitudes toward the wise utilization of our environment, methods for involving children at an early age in ecological activities should be practiced by all conservation and youth oriented agencies.

A way to use a plot of ground for transition study is to deliberately alter it to encourage the "homemaking" habits of local animals. Once the plots have been invaded by certain animal species, their "life styles" can also be observed. As with plants, the biological and physical factors in a plot will determine the type and distribution of organisms found there. Some suggestions for creating different habitats are:

1. Clear an area along a 20 foot strip which begins at the edge of a marsh or pond. Distribute pieces of log and/or wood along the length of the cleared area and begin to observe for the invasion of various types of organisms, plant and animal.

2. Parallel to the above strip, create another plot by clearing and covering with gravel.

3. Repeat Number 2 and cover with sand.

4. Always leave some area as it would be found naturally for purposes of comparison.

5. Pile wood or stones at a prairie or woodlot "edge".

6. A portion of forest could be cleared of ground cover and shrubs.

Careful, long term records of results should be kept by the youngsters. Perhaps permanent records could be kept, used, and added to by groups over the years.

The expense of establishing study plots is minimal. Ordinary garden tools, tillers, spades, hoes, forked spades, etc. are about all the equipment needed. Additional equipment such as saws, pruning shears, scythes, may be needed to help clear areas. Often it is possible to obtain equipment and material such as rocks and logs by seeking donors. Garden shops and feed stores might be an excellent free source of pesticides, herbicides, and fertilizer should you wish to experiment with these compounds.

FISH WATCHING

So often outdoor excursions have no follow-up activities. Here is one follow-up for a visit to a lake.

Plan the excursion so that you have time and equipment to catch minnows or other small fish. Do the catching near the time to leave for home. Then the fish won't be left to get too warm or suffocate during the day. Be conservative; allow only a few fish per student. Crowded conditions will cause the death of all the fish.

Some equipment is necessary. Other equipment is handy for greater success:

1. large plastic bags for carrying fish (inflate and tie after filling 1/2 full of water and adding only a few fish) OR, plastic pails.

2. aquarium nets or dip nets for catching fish. A seine (two-man sweep net) works best - but plan to get wet if you use one.

3. ice cubes to keep fish cool on a hot day - put into containers.

Duplicate the following guide sheets and distribute them to the students. Allow them to creatively develop ways of investigating their fish both at school or camp and at home. Encourage both verbal and graphic reports and have students share their ideas.

FISH WATCHING

Have you heard of people watching birds? Some do. Others watch buildings being constructed and some people watch other people. But how many people have you heard of that watch fish?

Here is your chance to be original. Be a fish watcher. You can show off to friends and confuse your teacher. You'll learn things from direct observation that no one else knows. Parents will think you're a genius.

This paper tells you how to become an original fish watcher. (However, we cannot guarantee that being a fish watcher will make you more popular with ordinary people.)

Minnow

Silversides

Any Fish Will Do

If you already have a goldfish bowl or a tank with guppies or other exotic fish, you have a good start on fish watching. If you don't have any fish now and don't want to spend much money, you can get a few minnows from a bait store.

Maybe you can catch your own minnows in a lake. Minnows should be kept in cold water. They, as all fish, need pond water, lake water or well water. The tap water in cities and towns has chlorine in it which will kill fish. You can use tap water if you drive the chlorine out by boiling and then vigorously stirring the water after it cools. Or, you can add a small pinch of sodium-thiosulphate per gallon of tap water. The sodium-thiosulphate is photographic "hypo." It can be bought cheaply in large boxes at photo stores and expensively in small bottles at pet shops.

Minnows will eat regular fish food. Don't get too many minnows. They will die from lack of air if they are too crowded. One or two small minnows per wide mouthed container (like a 1/2 gallon plastic ice cream container) is best. Six to one dozen may live in a pail. The wider the container the more air surface it gives the fish. A bath tub works very well for the fish, but it is difficult to observe the fish closely in it without joining them. Also, others usually object to this arrangement.

Fish can be observed easiest in flat-sided, transparent containers. But good fish-watchers can watch fish from almost any angle in whatever kind of container they have.

Mudminnow

Livebearer

What to Look for

Swimming -- Does your fish remain suspended in the water? Some kinds of fish sink to the bottom when they stop swimming.

What parts of the fish cause it to move? Be certain by watching closely. Do the side fins or the tail move it forward? Or, maybe both the fins and tail? Can your fish swim backwards? How does the fish do it? How does the fish move up or down? Does your fish move around or does it stay still? When does it move most; before, during, or after the time you feed it? Does it move when you do not? Does your fish swim when it is dark? How can you watch fish in the dark?! Many animals do not respond to red light. They do not seem to see it and act as though there were no light at all. Does your fish behave this way?

Other Fish -- Does your fish change its behavior when another fish is put in the container? Is there a difference in behavior when the other fish is a different kind or when it is the same kind of fish?

Do several of the same kind of fish act differently when they are together from when they are in separate containers?

Food -- Will your fish eat food from the surface of the water, food that is falling through the water, or food on the bottom? How is its mouth shaped? Would this have anything to do with how it eats? Compare the eating habits of different kinds of fish.

What kinds of food will your fish eat? Use only small bits of food and a hungry fish. Be sure that the fish has been undisturbed for a while so that it is not frightened. Can you tell when your fish is frightened? Test new foods in a container that can be easily cleaned out if the fish rejects the food. Decaying food can foul the water and kill the fish.

Can you train your fish to go to a special place to be fed? Tap the container before you put in food and always put the food in the same place for several days.

Hiding -- Will your fish hide if you give it some rocks or plastic plants to hide behind? Some fish will not. Be careful what you put into the fish's container when you experiment. Paper, cardboard, some wood, painted objects and anything soluble in water can introduce chemicals which are harmful to the fish.

Most metals, plastic or glass are safe in the water, although iron will rust. If you think something might be harmful, don't leave it in the water very long.

Does your fish stay in dark places more than in the light? Make one end of the container dark by covering it.

Breathing -- Fish breathe air that is dissolved in the water. Most of this air comes from the surface of the water. When there is not enough air in the water the fish will suffocate. When they are suffocating, fish come to the surface where there is more air in the water. Fish's gills will not work if they are not wet, so a fish cannot breathe dry air. It drowns if it is taken out of the water.

When your fish comes to the surface and looks like it is talking to you, don't try to talk back. Try to find it a bigger container and/or some fresh water so that it will not run out of air.

When does your fish breathe fastest; when it is in warm water or cool water? Don't change the water temperature on fish too rapidly or they will die of shock. Water can be cooled by dropping one or two ice cubes into the fish's container. Use a thermometer to measure the change. Then count the number of gulps that the fish makes in a minute. If the fish doesn't gulp to breathe, can you count the movement of the gill covers? Have someone help you time.

The container can be set into a pan of warm water to raise the temperature slowly. Measure temperature and count. Don't cook the poor fish.

Try this with several fish at several different temperatures. What can you conclude from your measurements?

Do different kinds of fish breathe at the same rate at the same temperatures? Does an excited fish breathe the same?

(Cold water minnows can tolerate a temperature range from 40° F. to 75° F. Guppies and other "tropical" fish can tolerate 65° F. to 85° F.)

Reflexes

What makes your fish jump or move quickly with a start? Be careful not to frighten your fish too severely or it might harm itself by dashing against the sides of the container.

Does your fish jump when it sees a flash of bright light? Try different stimuli: vibrations, taps, thumps, moving objects, shadows, shapes, sounds. Try the same stimulus over again. Does it work a third and fourth time?

Try Again

Fish do not live long lives naturally, and if the conditions you provide are not ideal, their lives may be shortened considerably. Also, you

may make mistakes, and accidents will occur which may cause a fish to get sick or to die.

As a fish-watcher you should try to be a good experimenter. Try not to deliberately cause discomfort to your fish. But if you aren't always successful, don't get too discouraged or unhappy about what you cause to happen to your fish. If you were a good experimenter you were trying hard to both take care of your fish and to learn more about the fish. If you learned something, and perhaps if you kept some notes about what you observed when you were fish-watching, you will be able to take better care of the next fish you watch.

Stickleback

Sunfish

MEASURING TO FIND ANSWERS

TAKING OUTDOOR TEMPERATURES

We often are interested in the temperature of the outside morning air. Especially if it appears to be a little nippy and we have reluctantly left a warm bed.

We take the thermometer reading or the weather report quite matter-of-factly, and we repeat that this morning it is 37 degrees.

But we rarely stop to think -- and there are very few people who realize -- that not every place in our outdoor locality is 37 degrees this morning.

So, how are we going to prove it?

A simple thermometer placed in several different locations will show a considerable variation in temperature.

Air temperature out in the open may be 37 degrees. Test it, but keep the bulb of the thermometer shielded from the sun or it will read too high a temperature.

Try the air temperature down in the grass. It may read 40 degrees in autumn. How about the temperature under the ground? The soil may be 45 degrees. Dig a hole and bury the thermometer bulb to see.

Why do some students sit on the south side of the building during lunch break on a chilly day? The temperature against the sheltered, sunny wall may be 50 degrees when tested.

Other places to find variations in temperature are on the south side, top, and north side of a hill; in sun and in shade; in bushes or weeds and on the lawn; by buildings and away from them; in wet soil and in dry soil; in the wind and in sheltered places; on the lawn and on the sidewalk or pavement; inside and outside of hollow trees; and inside and outside of a blown up plastic bag that is placed in the sun.

A map or picture diagram of such places as mentioned above, enable you to fill in the temperature readings. You will discover some very interesting relationships between the environment and the kind of miniature weather associated with it.

Weather predictions are in order after some relationships are found and then more measurements can be made to prove the predictions right or wrong.

CLASSIFYING SAND PARTICLES

Materials: sand - coarse
graph paper (1/8" square)
forceps or probe
hand lens
large salt crystals

Purpose: To stimulate students to look analytically at a common substance. In this case we will be looking at sand with the idea of putting the particles in order according to size, estimating the total number of sand grains in a pinch, examining the small particles through a hand lens, and putting these particles in order according to color.

This is a good activity for a rest period or evening during an outing. However, shelter from wind is essential for success. This study can be very successful when samples of sand are taken from the school yard, alley, or gutter, and examination done in a classroom.

Procedure A

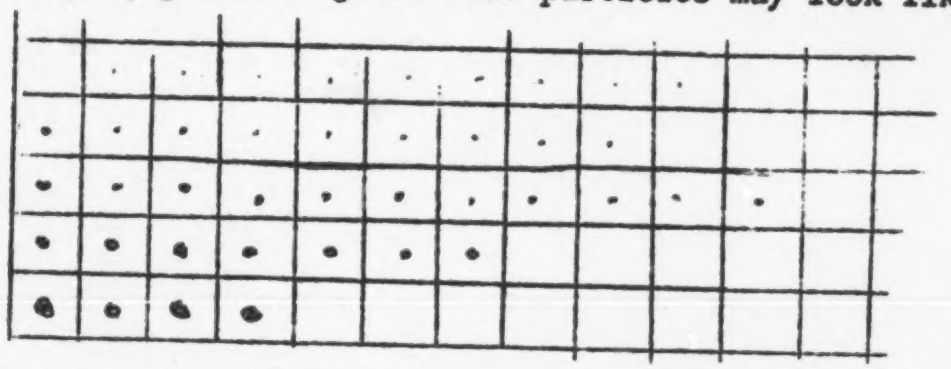
1. Distribute graph paper and then a pinch of sand placed on the paper.
2. Examine the sand with a hand lens.
3. With the forceps, pick out the ten largest sand particles beginning with the largest and working down.
4. Place the particles in a row on the graph paper with each particle occupying one square.
5. Pick out ten more large particles and place them in size order from the largest to the smallest. Put a drop of white glue on top of each sand particle. Let set.
6. Who has the largest sand particles? The smallest? Who has the greatest size difference within their 20 particles?

Procedure B

1. Place a pinch of sand on graph paper.
2. Divide the particles into five piles, each pile containing particles that differ in size from other piles so that one pile will contain the largest particles, another the smallest, and three intermediate sizes.
3. Select a row of squares on the graph paper and glue particles from the pile of largest particles to the paper with each particle occupying one square in the row.
4. Select the adjacent row of squares and starting from the same base line, glue down the particles of next smaller size.

5. Do the same for each pile of sand particles.

6. Graph paper with glued sand particles may look like this:



7. Which size particle is present in the greatest numbers?

8. Do size classifications compare among different students?

9. As an extension of analyzing particle sizes, a class graph can be made by cutting apart the rows of individual graphs and taping, end-to-end, rows of like particle sizes.

Procedure C

1. Draw around the perimeter of an area five graph squares by five graph squares.

2. Sprinkle another pinch of sand within the outline on the graph paper.

3. Using the hand lens, examine the particles in the graph paper squares.

4. Using the hand lens, count the sand particles in one square and estimate the total count.

5. Count the sand particles in the five squares of one row through the center of the area and estimate the total.

6. Count the particles in all squares and add for a total.

7. Discuss differences in individuals' estimate.

8. Discuss wide differences in participants' counts and possible reasons.

Procedure D

1. Mix salt crystals and sand about half and half.

2. Have the participants place a very small amount of this mixture on a paper.

3. Examine under strong magnifier or a microscope, if possible.

4. Discuss salt and sand characteristics and compare.

Procedure E

1. Select ten small sand particles.
2. Place them on a paper and examine under a hand lens or microscope.
3. Order them according to color (child determines the order).
4. Is there any other way that sand particles can be put in order?

SAND

SALT

SOIL TEMPERATURE ACTIVITY*

Materials for Each Team:
trowel
thermometer
tape to hold thermometer to scale
recording materials (paper, pencil)
clothing (depending on weather)

Object:
Measure soil temperature in different areas
Work in groups
Collect data
Form hypothesis based on data
Derive areas of application

Procedure:

1. The temperature outside is 70^{o} F. -- I wonder if the ground temperature is the same.
2. Pass out materials after demonstrating their use.
3. Work in groups of two or three.
4. Record data -- as a class.
5. Compare variations -- as to areas and vegetation.

Evaluation: Response and discussion.

Soil Temperature (Primary Grades)

Purpose: Show that temperature varies

Teacher Preparation:

1. Mark stations for groups with a stake and numbered paper -- around the school building.

Diagram:

2. Prepare a rough map of the building outline to record data upon.
3. Prepare individual maps for students to take with them to their location.
4. Pencils, trowel, thermometer.

*Developed by Peg Walls, Jean McCarthy, and Mary Lou Sanders

Prepare Group:

Take the group out and demonstrate how you would measure temperature in soil. Caution: thermometer is breakable. Bulb must be in ground. Count slowly to 100 before reading result. Demonstrate trowel use for the hole to place thermometer. Thermometer should be read in ground for best results. Record temperature at the site.

Activity:

Allow groups to go to stations. Give them about 20 minutes before reassembling.

Record Results:

Cut a colored strip -- 1" = 1 degree of temperature
Blue strip for reading next to building
Red strip for reading away from building
Paste next to each other at the appropriate location on map

Discuss:

Which temperature is greatest?
Did everyone get the same results?
What does the information on the map tell us?

Soil Temperature (Elementary Grades)

Equipment & Materials:

trowel
thermometer
tape to hold thermometer to scale
raincoats available
recording materials (paper, pencil)

Object:

Outdoors, group work, obtain soil temperatures, learn techniques of data collection, taking temperature to go on to other ideas from patterns and relationships observed

Procedure:

Questions about soil temperature directed to the class (motivate)
Hand out materials -- go
Return to classroom with data
Discuss -- post data -- see where discrepancies occur -- discuss techniques -- further questioning, etc.

Return to field next day to solve specific questions of individual teams -- done with more controlled techniques (hopefully)

Evaluation:

Post lab -- patterns? relationships? graphs? other questions?

Variations to be Aware of

1. Thermometer used
2. How deep you go
3. Where you go
4. Density or texture or consistency may make a difference
5. Present temperature (sun or shade)

Follow Up:

1. Make over-lays, etc. for class discussion.
2. Graphing (varying degrees of difficulty)
3. Use during all seasons (some areas)

Soil Temperature Lesson Applications

1. Year around observation (sampling, testing) of school site (consistent areas)

2. Gather data -- plot, graph, make own conclusions (applications, observations, etc.) Relate to cross disciplines

3. Seasonal observation: choose same site

   Soil temperature - Fall
   Oct. - soil - wet - dry
   Winter - soil temperature
   Cover of ground, snow, ice, litter, depth of snow
   Spring - soil temperature
   May - wet, dry, snow, sun, etc.

   Record seasonal data, relate to weather, sun, air, clouds, etc.
   Make a year to year follow up.

4. Follow up Patterns: graphs, etc.

   Soil, depth, color of soil, cover on surface

5. Comparison with U. S. Weather Bureau maps -- monthly or seasonal predictions -- soil temp -- team predictions -- soil temp rainfall, crop plantings.

Seasonal Variations

Change in Temp./Depth

Rates of absorption and radiation vs. types of soil -- heat loss and gain

Temp. variations with soil cover type

Correlations plant growth rate soil temp.

Soil temp. vs. soil organisms

Heat absorption in soil vs. heat absorption H_2O

Heat absorption dark soil vs. heat absorption light soil

To Show Change in Temperature in Soil

Act. #2 Difference in temp. of sub-soil -- distance from bldg. and against bldg.

Location	Trowel Length Away	Against Building
N_1	16° C.	16° C.
N_2	16° C.	16° C.
W_1	14° C.	17° C.
W_1	15° C.	14° C.
S_2	15° C.	16° C.
S_1	16.5° C.	18° C.
E_2	17° C.	18° C.
E_1	18° C.	18° C.

Materials per team:

2 thermometers
2 trowels

Procedure:

1. Measure trowel's length away from building.
2. Place thermometer against straight cut in subsoil (1/2 trowel blade deep).
3. Dig down 1/2 trowel blade against building. Place thermometer face against building. Replace soil.
4. Wait about 1-2 minutes.
5. Read and record.
6. Graph data -- make comparisons.

Act. #1 Difference in temp. of top soil and sub-soil 1' from building

Location	Top Soil	Sub-Soil
N_1	16° C.	16° C.
N_2	12° C.	16° C.
W_2	13° C.	14° C.
W_1	14° C.	15° C.
S_2	14° C.	15° C.
S_1	13° C.	16.5° C.
E_2	12.5° C.	17° C.
E_2	12.5° C.	18° C.

Materials per team:

2 thermometers
2 trowels

Procedure:

1. Measure two trowel's lengths away from the building.

2. Lay top soil thermometer face down onto bare soil. Dig 1/2 trowel blade length down and place thermometer face against straight cut. Cover with soil.

3. Wait about one minute.

4. Read and record.

5. Graph comparisons.

6. Consider transparencies (overlays) for overhead projector

Further Activities

Rationale: To develop an awareness of various types of change and variability. To teach children in the use of a scientific instrument -- the thermometer.

Procedure:

Pass out thermometers to the children. Through discussion, make sure they know how to read the thermometer. Then divide into groups to go out and measure the temperature by premarked spots:

a. Soil in the shade and sun -- 1" deep
b. Soil 1" deep vs. 8" deep
c. Soil on slope -- north vs. south exposure
d. Soil under grass vs. barren area
e. Soil near water vs. soil away from water
f. Soil near a building vs. away from a building
g. Temperature of soil in the various places morning vs. evening
h. Sandy soil vs. humus

Graph the results. Try to discover relationships and patterns. Check and recheck to verify hypotheses.

Objective: To compare the soil temperature with a body of water temperature and find out which takes the longest time to change.

Procedure: 1. Select pairs of teams.

2. Give each team a thermometer to keep for a 4-week period using the same one each time.

3. Team #1 -- Explain method of taking soil temperature.
   a. Use a trowel and dig a small hole in the ground trowel deep.
   b. Hold thermometer in vertical position with bulb end down.
   c. Place thermometer in hole and cover with soil removed when digging hole. Keep in soil at least five minutes. Take the soil temp. each morning and evening for this 4-week period using the same site each time. Be sure to write temp. in notebook each time.

4. Team #2 -- Explain method of taking water temp.
   a. Tie piece of cord to top of thermometer and a sinker on the cord.
   b. Standing on dock or side of pool at 4 ft. level, let thermometer hang down in water for a period of five minutes or more (no more than ten minutes). Take the temp. of the water at a 4 ft. depth each morning and evening for the same period of time. Be sure to write temperature in notebook each time.

5. Each team keeps a graph of their findings.

Evaluation: Using graphs, compare the changes of soil and water and make decision which (soil or water) takes the longest time to change.

PACING AS A MEANS OF MEASUREMENT

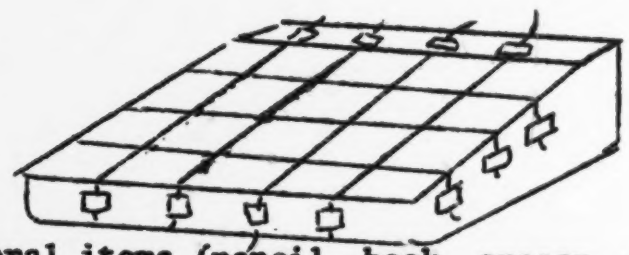
A pace is made by starting with the right (or left) foot. Move it forward one normal step. Move the left (or right) foot forward one normal step. This is one pace. (Both the left and right foot are moved.) Count each time the same foot strikes the ground. String a 30-foot rope or string in the school yard (any length might be used as long as it is a known length). Have each child pace it and divide his number of paces into 30 feet to find the average length for a pace. Perhaps each student should pace the rope several times until the length of their stride becomes even. A normal walking stride is most accurate. It is difficult to pace consistently if the stride is stretched.

Have them practice the pacing technique by measuring distances between objects on the school ground, measuring the length of the school, etc. They can check their accuracy by actually measuring the paced distance with the 30-foot rope.

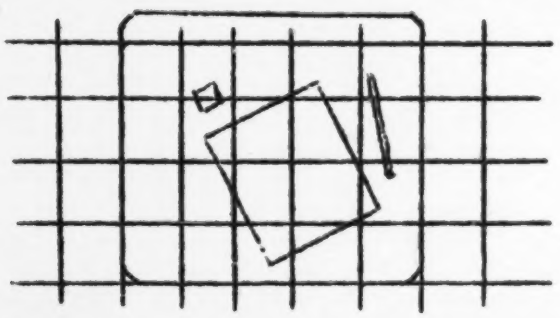
This method can be used for mapping (see Mapping Large Areas) or for measuring large distances. Scout troups find it interesting to pace distances hiked. If they work in groups of four or five, only one needs to count at a time. The switch can be made at the blow of a whistle. These distances can be converted into miles at the end of the hike.

MAP DRAWING - INTRODUCTION

Introducing a grid gives a child a wonderful tool for mapping. In the case of the desk top map a four inch grid can be made across the desk with string and masking tape. Cut string to extend across the desk and other pieces to stretch away from the child across the desk. Anchor the string pieces with masking tape along the side of the desk. Space the string four inches apart going in both directions.



Place several items (pencil, book, eraser, etc.) out on the desk in random fashion. Use one inch graph paper to draw the map of the desk top and the items on it.



It will be very natural for you to "teach" the children to identify each space by placing numerals or letters along the sides of the grid. However, if you do not teach this method of order it will be developed by those who need it. Those who do not need this should not have a chore type task imposed upon them. When they find a need they will make use of the system you suggest or invent a better one.

When the children complete their maps using the grid their results will show more accurate size and spacing relationships.

Now, try the same map using a smaller grid, one half inch. With most classes it is best to do the same map so the idea of scale is very obvious.

By now the children are able to draw a representation of an area, using a grid and using a number and different scales of size.

The next mapping experience can be a table top map, where the children plan a three dimensional setting establishing a grid and mapping on different size grid papers.

Or, if you have a tiled floor, you have built-in grid for mapping a portion of the room. (Do not attempt to use this as a grid for the whole room unless one or two individuals wish to.)

Establish a perimeter with masking tape and place items on the floor in the area to map. One class puts streets on with tape and houses out of block or cardboard. This might represent the neighborhood around the school. One floor tile equals one block (depending on the size of the tile). Landmarks such as the school, a church, etc. are shown with cardboard or other things.

Next, the children will map their classroom using a real grid or an imaginary grid. To establish a real grid the class will need a yardstick (several would be best), masking tape, clothesline, twine or heavy string (approximately 120 yards or more or 1,440 feet).

With the yardstick and chalk or tape, mark each yard along all walls starting with one corner of the room. Place a numeral, letter, or other name on the tape. Place the masking tape at eye level so all can see the markings from their desks. From these markers the children should try to imagine the grid that would criss-cross the room. When most children can successfully imagine this grid, maps can be drawn by all members of the class.

If members of the class have difficulty imagining this line it is best to obtain the clothesline, twine, or string to lay the grid line from the markers and then draw the maps.

Either way you do this, allow a great deal of freedom to move around the room to verify the accuracy of the maps.

Games

Grid games, i.e. checkers or chess, can be introduced at any point during these activities.

Grid games can be invented, i.e. set up two players opposite each other, but with a barrier between (notebook set on end, etc.). The first player establishes a grid size, second player draws grid or obtains prepared paper.

Using colored toothpicks, buttons, small blocks, etc. first player places one piece at a time and tells second player where he is putting his piece, he includes names of item, color, and location on the grid. The point is to create an interesting design that is duplicated by player Number 2 by using oral directions only. There are many language and communication skills developed during this "play."

Map Drawing Can Now Progress Outdoors

Cut a quantity of 12 x 18 drawing paper to 12 x 12 dimensions. (This will be used many times later so make plenty!) Have each child bring heavy cardboard from home and cut a 12 x 12 square piece to use as a backing. Make sure they are square. Tape can be used to fasten map paper to the cardboard.

In the preceding mapping exercises, the encompassing square was already laid out for the students (desk top, room). Now the teams must figure out how to make their own square plot.

Give each team four 12 ft. 6 inch lengths of twine (preferably masoners line as it stretches tight and does not tangle too easily), four large spikes, drawing paper, a cardboard cut the same size as the drawing paper, a string which reaches across the drawing paper, and two tacks.

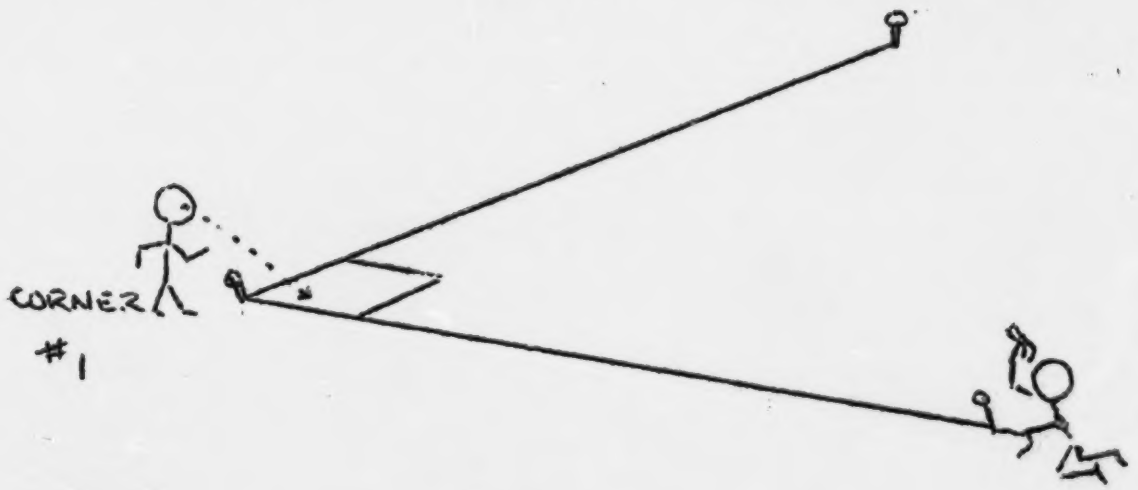
The game takes place on the school yard. Select some area of the lawn or play ground that is large enough so each team has approximately 25 ft. x 25 ft. area to work within.

Their first problem will be to enclose a 12-foot square and make it really square! Let them struggle with this for awhile. If the team combines its wits and the materials they've been given, they should solve the problem in the following way:

One piece of twine can be tied and spiked down as a starting line.

The first twine is pushed snuggly to the ground. The square cardboard is laid beside this rope with one corner touching the spike.

One team member remains at corner #1 and directs the corner #2 team member to the correct spot for corner #2. He does this by having corner #2 team member move right or left until the twine he is holding is exactly parallel and snuggly against the edge of the square cardboard.



Corner #3 is found in the same manner as #2.

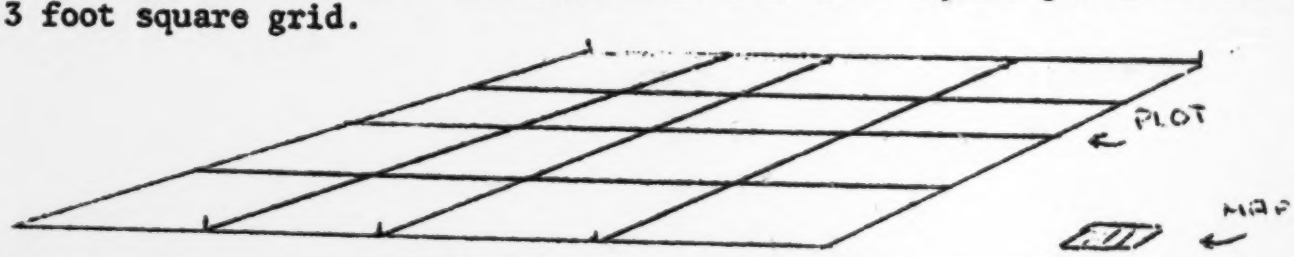
Corner #4 is the "proof of the pudding." If all corners are square, the remaining 12 foot twine should reach exactly from corner #3 to corner #4.

If it doesn't, they must carefully recheck each corner to find the point or points of their mistake. Some corrections they might make to reduce their errors are: (1) push the twine down the spike until it is snug against the ground; (2) pull the twine taut between the spikes; (3) make sure the point of the corner of the cardboard is exactly against the spike; and (4) don't use up the length of the twine by using over 6 inches to tie the two knots.

Once the plot is set up they may grid it using nails or tongue depressors and twine. Each team should have two 20-foot pieces of twine and 16 tongue depressors or nails. Each team should also have yardsticks.

If you don't have enough yardsticks or want to avoid the swordfights that often result, each group could measure and mark their 20-foot pieces of twine into 3-foot sections. These measured twines will come in handy later on.

A 3-foot grid is made by inserting nails or tongue depressors into the ground every three feet along boundary of the plot. The measuring twines are then stretched between two opposing nails and nails placed every three feet along these twines. The result is a 12 foot square plot, divided into a 3 foot square grid.



The scale is 1 inch = 1 foot (12 in. square map paper; 12 foot square lot)

A piece of paper is pushed onto the nail in one corner to mark it as corner #1 for reference while mapping. Several sizes of sheets of paper may be used as the objects to be mapped. Nails poked through the four corners will hold them down while being mapped. These are placed randomly in sections of the plot. They should be placed at various angles, with some sheets crossing from one section into another. The team sketches the papers in the correct sections and to scale. The papers are then removed and some inconspicuous marker placed in the spot the paper was in. Teams switch plots and maps. Attempts are made by each team to replace the papers in the correct positions on the plot by using the map given them by the other team.

Try switching plots several times. Have a discussion dealing with why some maps were hard to follow (incorrectly labeled, not drawn to scale, not gridded correctly, etc.).

Repeat the game using objects other than sheets of paper. This time make a key for the objects and record only the key symbol on the map. With this type of map they won't need to draw the object to scale.

MAPPING LARGE AREAS

The size of the area you can map using this technique depends only on the size of the mapping paper and how far you can see from one spot. Mapping Small Areas with Angles gives the class a good background for this activity.

Materials: sighting device (built from cardboard, a nail, and some glue)
mapping paper (30 x 30 paper made by taping drawing paper together)

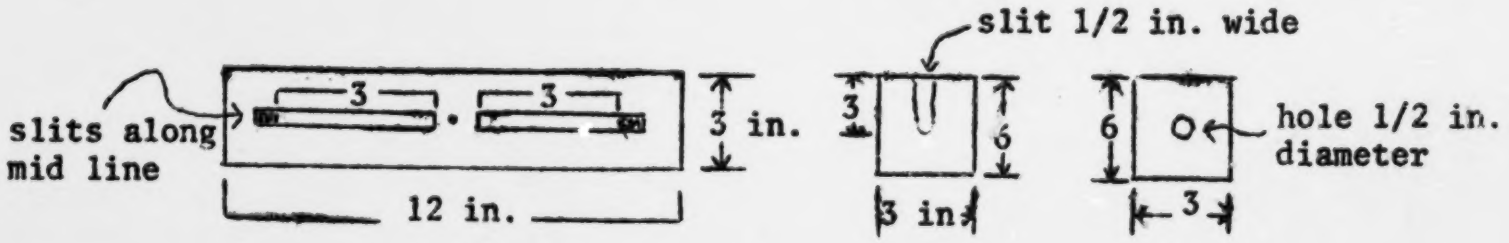
Procedure

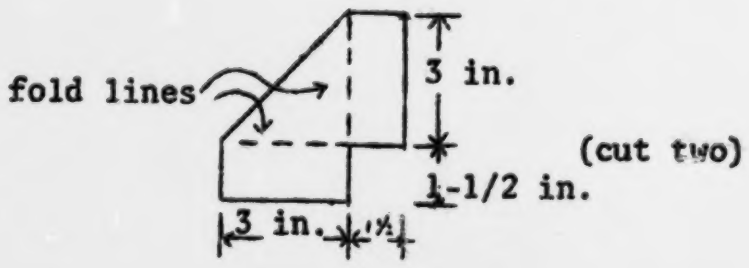
Select an area which has many things such as trees, paths, buildings, large rocks, picnic tables, etc. which can be mapped.

A scale must first be decided upon. You have a 12 inch square sheet of paper to work with. In the "Mapping Small Areas Using Angles" activity one inch equals one foot which allowed you to map a 12 foot square area on 12 inch square map paper. Depending on the size of your area, one inch equals one yard, one inch equals three yards, or one inch equals 10 yards might be most practical. If you have even larger areas to map it is possible to develop scales to accommodate them.

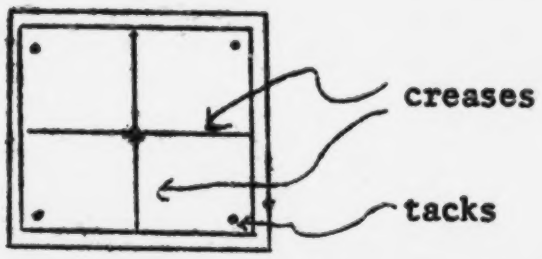
A measuring rope is made by marking off clothesline rope to the map scale. For example, if one inch = one yard, a mark is placed each yard along the measuring rope. The rope can be rolled onto a small stick to avoid tangles or knots while not in use.

Make patterns for the following parts of the sighting device. Use the dimensions shown in the diagram or larger ones. Dimensions smaller than those shown introduce greater possibility of errors. Use a heavy cardboard or, if possible, plywood.

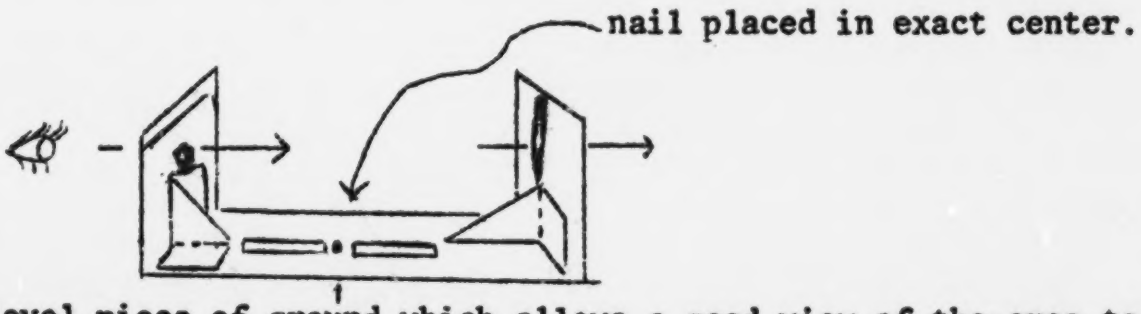




Each team makes a copy of your pattern, cuts their cardboard and assembles the device to look like the above diagram. A sheet of cardboard 30 in. square is used as a backing for the map paper. Fold the map paper into fourths and crease it. The center of the sheet is at the point where the creases cross. Tack the paper to the cardboard backing at the four corners.

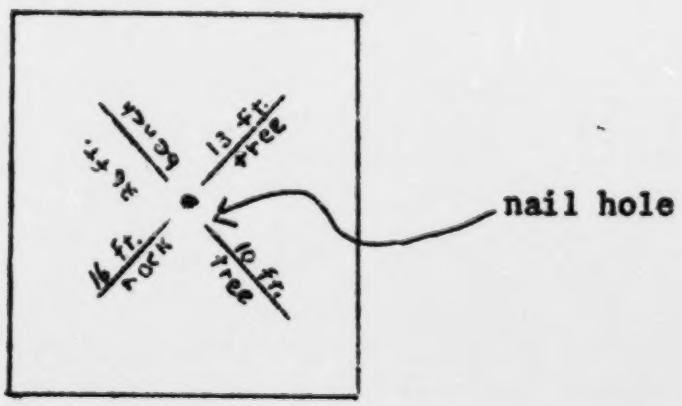


Push the nail into the sighting device through the center of the paper. Several layers of heavy tape might be used to reinforce the nail hole.

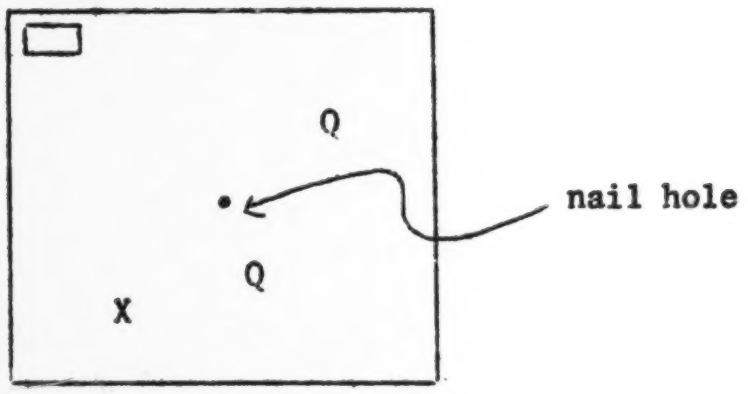


Find a level piece of ground which allows a good view of the area to be mapped. Lay the device on the ground. Remove the tacks holding the mapping paper and replace them with nails. Shove the nails into the ground so the device is firmly held to the ground.

One team member looks through the peephole, lining it up with the slit and sighting in some object to be mapped. When the object is in sight, he lightly draws a line on the map paper along the open slit in the bottom of the sighting device. This shows the direction of the object. Another team member measures the distance from the center nail of the sighting device to the object using the measuring rope (or use Pacing Techniques). Reduce the distance to scale. The object can be located at the exact distance along the line on the map at this time, or the distance to scale can be recorded next to the line showing the angle and the exact position plotted later. For example, the map paper, after being removed from the sighting device, might look like this:



The resulting map might look like this:



Scale: 1 inch = 1 yard

Key:

Object		Symbol
Tree	=	Q
Bench	=	▭
Rock	=	X

Mapping Very Large Objects

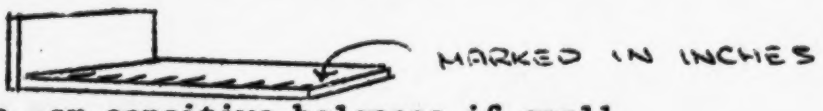
One side of a building can be plotted by sighting and measuring several points and sketching the side of the building in. The rest of the building can be plotted by taking direct measurements of the building.

The same procedure may be used for mapping other large objects. Things you can see across like patches of vegetation, bare spots of ground, etc. may be plotted by sighting in and measuring several points around the outside edge. The rest of the shape can then be sketched in.

POPULATION DYNAMICS OF FISH

This study is designed to give students an understanding of the steps and processes a biologist goes through to gain an understanding of the characteristics of a population of animals. This study is then distinctive in that it compares data collected from a great number of animals which are all of like kind. An understanding of a population cannot be inferred from an understanding of one individual.

Equipment: 1 lake with gently sloping shores
6 fish traps, and if traps are used, 2 boats
or 3 seines (large 2-man nets sold in sporting goods stores)
10 measuring boards which look like this:



3-10 postal scales, or sensitive balances if small minnows are to be weighed
10 pair dissecting scissors
10 plastic pails
clipboards
graph paper
pencils
formaldehyde (1 part of concentrated solution to 5 parts of water to kill and preserve fish); sold in drugstores
plastic bags

If fish traps are used they should be set the night before fish are to be studied and the instructors should collect them and bring them to shore for student use. Seines can be handled by students. Obviously, they are going to get wet up to their arm pits if not beyond, so everyone concerned should be properly informed. Life jackets may be needed for younger students.

Fish traps provide the extra dimension of obtaining fish from different locations and depths. However, they are more time consuming to use and take away some of the more enjoyable (although hectic) involvement for students.

Students should work in teams of three or four, rotating tasks for greatest experience.

Morning -

1. Net at least 50 fish of the most numerous species. Quickly place these fish as they are collected in a plastic pail of fresh water. Ideally, this species will be all sizes of a medium sized predator such as sunfish, crappie, or bass. If such fish are not available, bullhead, catfish, suckers, etc. are next best because of their size. If no medium sized fish are available, various species of minnows will work, but are difficult to handle with accuracy because of small size.

2. In the process of obtaining at least 50 of the study species, count the number of different species and the number of members of each different species found in the net. If species cannot be readily identified by name, preserve one specimen of each species instead, and label the bag with the total number counted. Also note the average number of fish per netting. Quickly return all fish other than the study species to the lake at a place where seining is not being conducted.

3. Gather the following data on the study species and record. For each fish:

   a. Total length. Lay fish on wet measuring board.

   b. Weight. Put fish on wet scale platform. If fish flops out you might weigh a wet plastic bag first, weigh the fish in the plastic bag, and subtract the plastic bag weight.

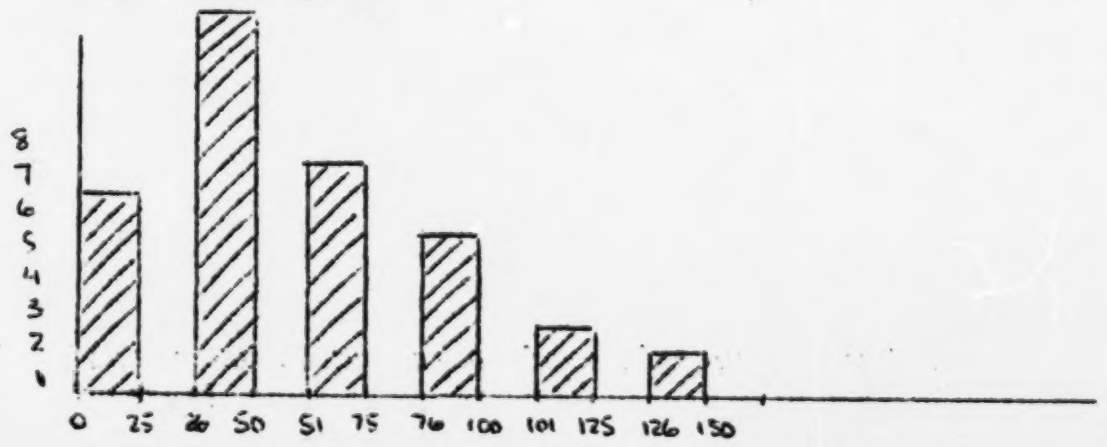
Fish	Length MM	Weight
1	45	-
2	30	-
3	25	-
4	40	-
5	30	-

   c. Select and preserve in plastic bags with formaldehyde three fish from each 25mm range in length (for sunfish). That is, collect three fish between 0-25mm (if any), three fish between 25 and 50, three fish between 50 and 75, etc. or use other size ranges as seems appropriate for your study species.

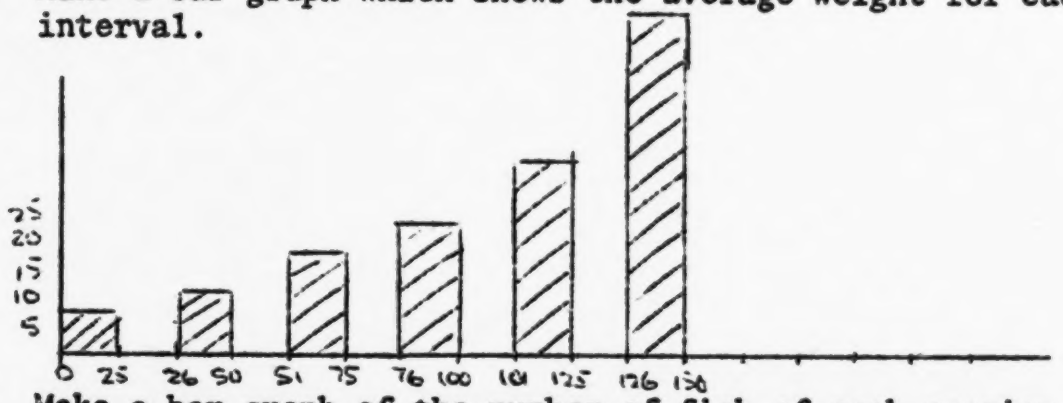
   d. Quickly return all other measured fish to lake at a place where seining is not being conducted.

Afternoon -

1. Make a bar graph of the number of fish in each 25mm interval of measured length.



2. Make a bar graph which shows the average weight for each length interval.



3. Make a bar graph of the number of fish of each species that was collected. Note the total number of fish of all species collected also.

4. Remove and combine stomach contents of the three preserved fish from each size range. Use scissors for dissection.

   a. Place stomach contents in water in a dish or white bottomed pan.

   b. Separate and tally (and identify if possible) the kinds and numbers of animals and plants from the stomach contents.

   c. Tally stomach contents for each size range of fish.

   d. Make a chart comparing stomach contents to size range of fish.

5. Remove two or three scales from each fish. Combine scales from each size range. Best means of preserving scales so they will not be lost is to rinse them off in a small dish of detergent water, dry them, and then glue them, with white glue, directly to a microscope slide. Use one microscope slide for each size range of fish. Label slide as to size range and collecting team. Scales are saved for later age determinations.

Classroom Followup -

1. Discuss how the team graphs and data might be interpreted.

2. Combine team data on length of fish and construct a histogram with 1 cm intervals (or other appropriate interval).

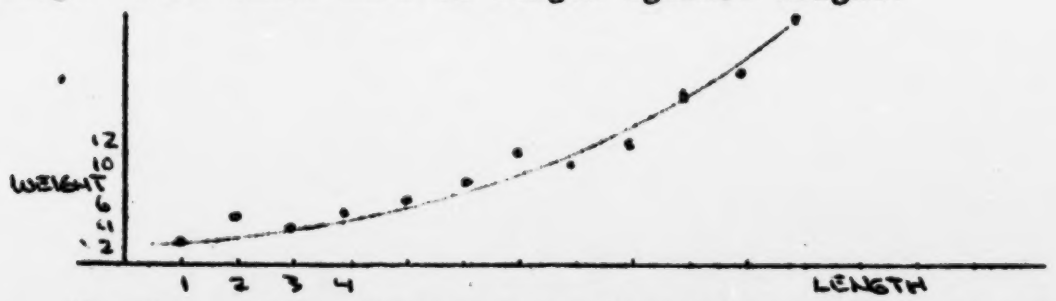
   a. Usually a steady decline in numbers is noticed as fish become larger. Consider mortality rates.

b. Irregular distribution of numbers might indicate spawning success from year to year.

c. Question of length related to age may arise. Can be checked out by analyzing scales. Bands of closely spaced growth rings separated by bands of broadly spaced growth rings indicate one year's growth.

d. Consider inadequacies in data.

3. Graph total class data on length against weight.



a. Usually weight increases as length increases and usually the rate of increase in weight is greater than the rate of increase in length.

b. Rate of weight gain may increase as length increases.

c. Consider health, rate of growth, and "fatness" of individual fish against a plotted norm.

4. Combine team data on contents of stomachs in successive length categories.

a. Crustaceans make up a large proportion of what is consumed by small sunfish, insect larvae by medium sized fish, some minnows and other fish by large sunfish (large fish are only rarely seined in the shallows along shore).

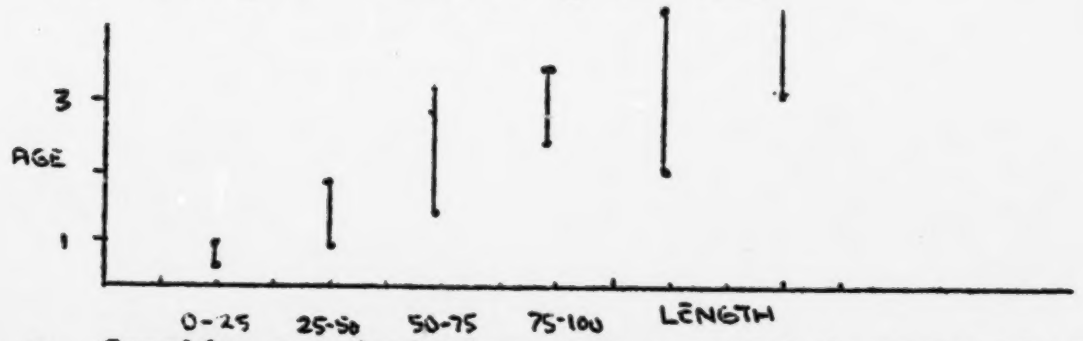
b. Note the relative quantity of food being consumed by successive size categories of fish. Consider the numbers of fish counted in each size category.

c. Estimate, or calculate roughly, the numbers and kind of food-animals required to supply each size category of fish - all categories of fish.

5. Using a microscope or strong hand lens, determine the age distribution and the average age of each size category of fish from the scales (see 2c above).

a. A wide distribution may indicate fluctuations in growing conditions from year to year.

6. Graph the age distribution against size.



a. Consider any deviations from a smooth increase of size with age and discuss possible causes.

b. Consider inadequacies in data.

7. An extension of this investigation would be to survey the availability of food supply for the successive sizes of fish in the lake. Dip nets, bottom samplers, and traps would be needed.